Preliminary paleoecological insights from the Pliocene avifauna of Kanapoi, Kenya: implications for the ecology of *Australopithecus anamensis*

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ABSTRACT

Fossil bird remains from the Pliocene hominin-bearing locality of Kanapoi comprise >100 elements representing at least 10 avian families, including previously undescribed elements referred to the 'giant' Pliocene marabou stork *Leptoptilos* cf. *falconeri*. The taxonomic composition of the Kanapoi fossil avifauna reveals an assemblage with a substantial aquatic component, corroborating geological evidence of this locality's close proximity to a large, slow-moving body of water. Both the taxonomic composition and relative abundance of avian higher-level clades at Kanapoi stand in stark contrast to the avifauna from the slightly older (~4.4 Ma vs. 4.2 Ma) hominin-bearing Lower Aramis Member of Ethiopia, which has been interpreted as representing a mesic woodland paleoenvironment far from water. In general, the taxonomic composition of the Kanapoi avifauna resembles that from the Miocene hominoid-bearing locality of Lothagam (though Kanapoi is more diverse), and the aquatic character of the Kanapoi avifauna supports the idea that the environmental conditions experienced by *Australopithecus anamensis* at Kanapoi were markedly different from those experienced by *Ardipithecus ramidus* at Aramis. Additionally, the relative abundance of marabou stork (*Leptoptilos*) remains at Kanapoi may suggest a longstanding commensal relationship between total-clade humans and facultatively scavenging marabous. Additional avian remains from nearby fossil localities (e.g., the Nachukui Formation), ranging in age from 3.26-0.8 Ma, reveal the long-term persistence of an aquatic avifauna in the region.

Keywords: Paleornithology, Paleoecology, *Australopithecus anamensis*, Marabou, Pliocene, Fossil birds

1. Introduction

Deciphering the environmental conditions experienced by Pliocene hominins in East Africa holds important implications for interpreting the lifestyle and selection pressures influencing early human evolution (Olson and Rasmussen, 1986). Collecting efforts over the last ~25 years in the Kenyan Pliocene locality of Kanapoi (4.2 Ma) have revealed a diverse vertebrate fauna comprising fishes, mammals, amphibians, lepidosaurs, turtles, crocodilians, and birds (Harris et al., 2003). However, despite the promising potential of fossil birds as paleoenvironmental indicators (Olson and Rasmussen, 1986; Serjeantson, 2009; Finlayson et al., 2011), to date only 10 total avian specimens have been noted from this important locality, and neither these remains nor their value as environmental proxies have been treated in detail (Harris et al., 2003). Of these previously reported specimens, seven comprise collections of ostrich eggshell fragments (Struthionidae), along with isolated bones from one darter (Anhingidae), one stork (Ciconiidae: *Mycteria*), and a putative duck (Anatidae).

Here, 100 avian specimens from Kanapoi were evaluated, along with 23 additional specimens from more recent deposits located nearby, ranging in age from ~3.26-0.8 Ma. These include specimens collected during the 1990s via surface collection and screen washing, and material collected during the 2000s via surface collection. The entire collection comprises skeletal remains from a minimum of 12 extant avian families (with at least 9 represented from Kanapoi alone), in addition to numerous records of ostrich eggshell. The relatively abundant avian remains from Kanapoi are notable, as the intrinsic fragility and small size of bird bones renders them absent or rare at most East African hominin-bearing assemblages (Louchart et al., 2009). This material enables

70 comparison of the avifaunal composition of Kanapoi with that of the slightly older
71 hominin-bearing locality at Aramis, Ethiopia (Louchart et al., 2009). Although the
72 tetrapod assemblage from Kanapoi was initially interpreted as broadly similar to that
73 from Aramis (Harris et al., 2003), more recent work has indicated divergent ecological
74 settings (Louchart et al., 2009). However, no comparisons between the Aramis and
75 Kanapoi avifaunas have yet been conducted, given the scarce attention avian remains
76 from Kanapoi have thus far received. The present study reveals that both the taxonomic
77 composition and ecological affinities of the Kanapoi avifauna differ markedly from those
78 of Aramis, corroborating other ecological proxies suggesting divergent ecological
79 settings for *Australopithecus anamensis* and *Ardipithecus ramidus* (see other
80 contributions in this special issue).
81 The vertebrate fossils from Kanapoi predominantly derive from vertic flood-plain
82 paleosols of the Kerio River, overlain by claystones deposited within the early Pliocene
83 Lonyumun Lake (Harris et al., 2003). The avian fossils collected from this locality reflect
84 this general ecological setting, and represent a considerably more aquatic avifauna than
85 that reported for Aramis (Louchart et al., 2009). These differences underscore the utility
86 of fossil birds as sensitive environmental indicators that may help shed light on the
87 environmental conditions experienced by early hominins in East Africa (Olson and
88 Rasmussen, 1986).
89
90 **2. Materials and methods**
91 *2.1 Institutional Abbreviations*
92 Institutional abbreviations used here are: KNM-KP: Kenya National Museum, Kanapoi

93 Formation; KNM-WT: Kenya National Museum, Nachukui Formation; OB: Kenya
94 National Museum, osteology collection
95
96 A complete list of the fossil material examined is provided in the Supplementary Online
97 Material (SOM) Tables S1 and S2.
98
99 *2.2. Fossil eggshell*
100
101 Nine specimens comprising multiple eggshell fragments from Kanapoi, discussed by
102 Harris et al. (2003); nine from more recent localities (SOM Table S1 and S2). All exhibit
103 the characteristic 'struthious' pore structure of modern *Struthio* (Sauer, 1972; Harris et
104 al., 2003), and are similar to *Struthio* eggshell reported from Lothagam (Harris and
105 Leakey, 2003; Harris et al., 2003).
106
107 *2.3. Fossil skeletal remains*
108
109 One hundred avian specimens from Kanapoi and 23 from more recent nearby localities
110 (principally the Nachukui Formation; see SOM Table S2) were evaluated. These
111 specimens were acquired both by surface collection and by screen washing. All material
112 examined that was collected throughout the 2000s was surface-collected.
113
114 *2.4. Selected extant comparative material*:
115

116 *Poicephalus meyeri* OB 274; *Leptoptilos cruminiferus* OB 35; *Mycteria ibis* OB 49,
117 *Pelecanus onocrotalus* OB 2334; *Alopochen aegyptiacus* OB 1637; *Pterocles exustus* OB
118 797; *Recurvirostra avosetta* OB 1517; *Alcedo cristata* OB 1117; *Turdus abyssinicus* OB
119 1693; *Trigonoceps occipitalis* OB 957; *Anhinga rufa* OB 1411; *Apus horus* OB 333
120
121 *2.5. Ecological analysis*
122
123 Pliocene avian skeletal remains from Kanapoi (*n*=54) and the more recent localities (*n*=7)
124 were diagnosed to the Family level (Passeriformes were diagnosed to Order), and
125 combined with published data from Aramis (*n*=263) (Louchart et al., 2009). Taxa were
126 divided among three ecological categories according to their general lifestyle habits (Del
127 Hoyo et al., 1992): "aquatic" (i.e., Anatidae, Alcedinidae, Anhingidae, Ciconiidae,
128 Charadriiformes, Pelecanidae), "terrestrial" (i.e., Accipitridae, Columbidae/Pteroclididae,
129 Passeriformes, Psittacidae, Strigidae), and "aerial insectivore" (Apodidae). Results are
130 depicted as pie charts in Fig. 1. Ecological data from Aramis were extracted from
131 Louchart et al. (2009). Data from the more recent localities in the West Turkana region
132 were combined, although these data should be treated with caution as they represent a
133 wide temporal range, from 3.26 Ma in the case of Lomekwi to 0.8 Ma in the case of
134 Todenyang (Brown et al., 2001; McDougall and Brown, 2008). Age estimates for these
135 additional localities are provided in the SOM Table S2.
136
137 **3. Results**
138 *3.1. Ecological analysis*

139

140 The most frequently represented avian ecologies differ markedly between the skeletal
141 remains from Aramis and the Kenyan localities (Fig. 3). Aramis is dominated by species
142 exhibiting terrestrial/arboreal ecologies (95%; largely parrots, game birds, owls,
143 songbirds, pigeons, and diurnal raptors; Louchart et al., 2009). By contrast, terrestrial
144 birds comprise a much smaller percentage of the avifaunas of both Kanapoi (46%), and
145 the more recent localities (29%). Whereas aquatic taxa and aerial insectivores comprise
146 only a minor component of the Aramis avifauna (4% and <1%, respectively), these
147 groups are comparatively dominant in the localities from the Turkana region, where they
148 combine to represent 54% of the specimens from Kanapoi (30% aquatic and 24% aerial
149 insectivore), and 71% from the more recent localities (all aquatic).

150

151 *3.2. Taxonomic comparisons*

152 Much like the results of the ecological comparisons (Fig. 4), the taxonomic composition
153 of the Aramis avifauna differs substantially from that of Kanapoi and the more recent
154 localities (Fig. 2). The most abundantly represented groups at Aramis, such as parrots
155 (Psittacidae; 36% of the Aramis skeletal remains), land fowl (Galliformes; 29%), and
156 barn owls (Tytonidae; 8%), are virtually absent from the remains from Kanapoi and the
157 more recent localities, which together yield only a single parrot bone (KNM-KP 58729,
158 likely referable to *Poicephalus*, not *Agapornis*, which is present at Aramis), and no
159 galliforms or tytonids. The most abundantly represented non-passeriform groups at
160 Kanapoi and the more recent localities are swifts (Apodidae; 24% of the Kanapoi
161 avifauna), storks (Ciconiidae; 17% of the Kanapoi avifauna and 29% of the more recent

localities), darters (Anhingidae; 6% of the Kanapoi avifauna), and vultures (Accipitridae; 29% of the more recent localities).

3.3. Fossil material examined

Order Struthioniformes

Family Struthionidae

Genus *Struthio*

Material Examined: KNM-KP 36599, KNM-KP 30262, KNM-KP 30490, KNM-KP 32522, KNM-KP 30154, KNM-KP 29300, KNM-KP 30223, KNM-KP 30221, KNM-KP 30154, KNM-WT 14283B, KNM-WT 14278, KNM-WT 14292, KNM-WT 14279, KNM-WT 464, KNM-WT 14235, KNM-WT 479, KNM-WT 424, KNM-WT 3499

Locality and Horizon:

KNM-KP 30490: Kanapoi (close to Wambua's hom, below sand in silt/clay)

KNM-KP 32522: Kanapoi (lower delta sands, below lake beds)

KNM-KP 36599, KNM-KP 30262, KNM-KP 29300, KNM-KP 30223, KNM-KP 30221, KNM-KP 30154: Kanapoi

KNM-KP 29300: Kanapoi (below tuff)

KNM-KP 30154: Kanapoi (below tuff)

KNM-WT 14283B: West Turkana (Kaitio, Detaic)

KNM-WT 14278: West Turkana (Kaitio, in gravels)

KNM-WT 14292: West Turkana (Kaitio, marginal lacustrine/deltaic)

185 KNM-WT 14279: West Turkana (Kaitio, North, in channel)

186 KNM-WT 464: West Turkana (Kalochoro, fluvial)

187 KNM-WT 14235: West Turkana (Lokapetemoe, Below the ?Nariokotome Tuff)

188 KNM-WT 479: West Turkana (Nachukui; fluvial)

189 KNM-WT 424: West Turkana (Nachukui; Nariokotome Member, deltaic, in gravels)

190 KNM-WT 3499: West Turkana (Nachukui, Nariokotome Member, lake margins)

191

192 Comparisons:

193 The following specimens were reported by Harris et al. (2003): KNM-KP 36599, KNM-
194 KP 30262, KNM-KP 30490, KNM-KP 32522, KNM-KP 29300, KNM-KP 30223, KNM-
195 KP 30221, while the following specimens, all consisting of broken *Struthio* eggshell, are
196 reported here for the first time: KNM-KP 30154, KNM-WT 14283B, KNM-WT 14278,
197 KNM-WT 14292, KNM-WT 14279,WT 464, KNM-WT 14235, KNM-WT 479, KNM-
198 WT 424, KNM-WT 3499. As discussed by Harris et al. (2003) and noted above, the
199 ostrich eggshell fragments exhibit the 'struthious' pore pattern diagnostic of extant
200 ostriches (Sauer, 1972). Additional, more detailed comparisons between these specimens
201 and other *Struthio* eggshell described from the Neogene of Africa (e.g., Harrison and
202 Msuya, 2005) would be worthwhile, although such comparisons were not undertaken
203 here. Although *Struthio* eggshell is among the most commonly recovered avian fossils
204 from Kanapoi and the more recent Turkana localities, no skeletal material referable to
205 *Struthio* has yet been recovered. Numerous fossils recovered from these localities that
206 had been provisionally referred to *Struthio* are here recognized instead as belonging to
207 marabou storks (*Leptoptilos*).

208

209 **Order Suliformes**

210 **Family Anhingidae**

211 **Genus *Anhinga***

212 Figures: 1D, 1I

213

214 Material examined: KNM-KP 53159, KNM-KP 39325, KNM-KP 31743, KNM-WT

215 14570

216

217 Locality and horizon: KNM-KP 53159, KNM-KP 39325, KNM-KP 31743 are from

218 Kanapoi; KNM-WT 14570 is from West Turkana (NC II Photo R16/6)

219

220 Comparisons: KNM-KP 53159: Well-preserved distal extremity of right tibiotarsus

221 (lacking spina fibulae and tuberculum retinacula m. fibularis), very fragmentary distal

222 right femur lacking the condylus lateralis, very fragmentary distal extremity of left ulna,

223 exhibiting many broken surfaces, and two other unidentified fragments. Distal extremity

224 of the tibiotarsus agrees in all respects with that of the extant African darter, *Anhinga rufa*

225 OB 1411, but the spina fibulae is not attached along the lateral side of the bone, giving

226 the fossil a superficially narrower appearance. The tibiotarsus is very slightly smaller

227 than extant *A. rufa* OB 1411; the morphology of these elements is otherwise

228 indistinguishable (Fig. 1I). The depressio epicondylaris lateralis and medialis are of

229 comparable depth, with depressio epicondylaris lateralis exhibiting a sharp ridge along its

230 external surface. The pons supratendinius is of the same relative width in both the fossil

and OB 1411, and is deflected slightly proximomedially. The shape of the sulcus extensorius is similar in both the fossil and OB 1411; a fairly shallow depression extends from the canalis extensorius towards the proximal end of the bone. In both the fossil and OB 1411, a marked fossa exists on the lateral surface of the epicondylus medialis, and a small pit on the cranial surface of the epicondylus lateralis is positioned in the same place in both. The sulcus m. fibularis is positioned in the same area in both the fossil and OB 1411, and tuberculum retinaculi m. fibularis extends laterally to the same extent in both (although this is somewhat obscured in OB 1411 as the spina fibulae is still attached). Although very little of the femur is preserved, what is there compares closely with *A. rufa* OB 1411. Only the condylus medialis is preserved, but the preserved surface is similar in both the fossil and OB 1411, with a lateral deflection at its cranial terminus. A small nerve foramen enters the caudal surface of the intercondylar space, just above the cranial extent of the articular condyles. The femora exhibit a very shallow fossa poplitea. The tuberculum m. gastroc. lateralis is short, and positioned in the same area of both. On the cranial side, although the sulcus intercondylaris of the fossil is not preserved, the sulcus patellaris of both is extremely shallow. A crest leading from the cranial surface of the medial condyle is a marked ridge in both the fossil and OB 1411. The fossil ulna is very poorly preserved with numerous broken surfaces, but its general size compares well with extant *A. rufa* OB 1411.

KNM-KP 39325: Left humerus. Nearly complete and three dimensionally preserved, missing only the distalmost extremity of the bone. The fossil is indistinguishable from extant *A. rufa* OB 1411 (Fig. 1D).

KNM-KP 31743: Right distal humerus. The fossil compares favorably with the nearly complete fossil humerus KNM-KP 39325; however, the latter specimen is missing the distal-most portion of the bone. Where they can be compared, the tuberculum supracondylare ventrale of KNM-KP 31743 is slightly less pronounced, but this may be the product of weathering of the bone surface. The elements are practically identical in size.

KNM-WT 14570: Omal extremity of right coracoid, virtually indistinguishable from that of *A. rufa* OB 1411 in all respects. The bone surface is slightly weathered, making the articular surfaces more difficult to discern. The facies articularis humeralis, cotyla scapularis, and processus procoracoideus are preserved in their entirety. The cranial-most extent of the processus acrocoracoideus is missing; however, a long articular surface is preserved along the ridge of the processus acrocoracoideus from the facies articularis humeralis to the broken area, as in *A. rufa* OB 1411. The cotyla scapularis is very shallow, and slightly mediolaterally ovoid, as in *A. rufa*. The fossil is very slightly smaller than the corresponding region of the right coracoid of *A. rufa* OB 22. The processus acrocoracoideus appears to be slightly less deflected medially as in *A. rufa* OB 22.

Order Ciconiiformes

Family Ciconiidae

Genus *Leptoptilos cf. falconeri*

277 Figures: 2 A-J

278

279 Material examined: KNM-KP 50804, KNM-KP 50764, KNM-KP 50761, KNM-KP

280 50760, KNM-KP 50800, KNM-KP 53164, KNM-KP 51011, KNM-KP 56949, KNM-

281 WT 56350, KNM-WT 16081

282

283 Locality and horizon: KNM-KP 50804: Kanapoi (lacustrine sequence, delta sands)

284 KNM-KP 50764: Kanapoi (lacustrine sequence)

285 KNM-KP 50761: Kanapoi (lacustrine sequence)

286 KNM-KP 50760: Kanapoi (lacustrine sequence)

287 KNM-KP 50800: Kanapoi (lacustrine sequence)

288 KNM-KP 53164: Kanapoi (upper fluvial sequence)

289 KNM-KP 51011: Kanapoi (lacustrine sequence, delta sands)

290 KNM-KP 56949: Kanapoi (deltaic)

291 KNM-WT 56350: West Turkana, Tondenyang (Nariokotome Member, lake margins)

292 KNM-WT 16081: West Turkana, KLI (Photo R14/3)

293

294 Comparisons: KNM-KP 50804: Distal right humerus. The specimen is not especially well

295 preserved, and some surfaces are covered in sediment. Although the specimen is slightly

296 larger than extant *L. crumeniferus* OB 35, it is otherwise indistinguishable–all visible

297 morphology of the fossil humerus and that of OB 35 agrees. KNM-KP 50804 is better

298 preserved than KNM-KP 51011 as the surface is not flattened, and the dorsal edge of the

299 bone is preserved. The specimen compares closely with the the humerus of the Pliocene

300 marabou *Leptoptilos lüi* (Zhang et al., 2012).

301

302 KNM-KP 50764: Right wrist region of a large bird. Preserved elements are distal-most
303 right ulna, radiale, ulnare, and proximal-most carpometacarpus in several pieces. The
304 proximal extremity of the carpometacarpus is preserved; it compares with *Leptoptilos*
305 *crumeniferus* OB 35 in all respects (Fig. 2H). Notably, major pneumatic foramina
306 perforate the proximal carpometacarpus—a diagnostic feature for *Leptoptilos* (Louchart
307 et al., 2005), and are present in the same positions as in extant *L. crumeniferus*. These are
308 on the proximal articular surface, within the fossa infratrochlearis. On the ulna, the
309 position and shape of the shallow depressio radialis is similar in the fossil and OB 35.
310 The angle and position of the condylus dorsalis ulnae is comparable with that of OB 35.
311 A small tubercle projects just medially with respect to the sulcus intercondylaris, and
312 projects to a comparable degree as OB 35. In proximal view, all aspects of the ulnar
313 morphology compares with extant *L. crumeniferus*, including the position and relative
314 size of the substantial pneumatic foramen between the condylus ventralis ulnae and
315 tuberculum carpale. Ulnare: Opposite to the incisura metacarpalis, along the crus breve, a
316 marked depression runs along the length of the bone in both the fossil and extant *L.*
317 *crumeniferus*. Most of the crus breve is broken off (Fig. 2I). A large pneumatic foramen
318 is present in the middle of the dorsal surface of the modern specimen, with a comparable
319 foramen in that position on the fossil. All visible aspects of the radiale compare well with
320 OB 35. One end of the fossil is broken off (this end exhibits a small pneumatic foramen
321 in OB 35). Several other small fossil bone fragments from this specimen are not
322 definitively attributable to particular elements.

KNM-KP 50761: Phalanx distalis digiti majori of a massive bird. Morphology compares very closely with *L. crumeniferus* OB 35, but the fossil is larger. On its plantar surface, the fossil shows less pronounced excavation and no pneumatization towards the distal end with respect to OB 35. The distalmost extremity of the element is broken.

KNM-KP 50760: Pedal phalanx and radiale of a very large bird. Both are considerably larger than *L. crumeniferus* OB 35, but the morphology is otherwise generally indistinguishable (Fig. 2J).

KNM-KP 50800: Proximal tarsometatarsus including articular surfaces. The plantar surface of the hypotarsus is broken. Compares closely in every way (including size) with extant *L. crumeniferus* OB 35.

KNM-KP 53164: *Leptoptilos* skull. A fragmentary right quadrate is preserved, but extremely poorly. Much of the surface morphology is obscured either by breaks or by surrounding skull/jaw elements being fused to the surface. Very little can be said by way of comparison with extant *L. crumeniferus* at present on the basis of the quadrate due to its poor state of preservation. The neurocranium is crushed fairly flat dorsally. As a result, the caudal surface of the skull (which forms a vertical plane in *Leptoptilos*; Zhang et al., 2012) is greatly compressed. The caudal margin of the skull is sheared rostrally such that much of it lies roughly in the same plane as the dorsal surface of the skull. A prominent crista nuchalis transversa is observed on the left side of the skull that originally

346 would have separated the skull's dorsal surface from its roughly perpendicular caudal
347 surface. As in *L. lüi*, but not extant *L. crumeniferus* (Zhang et al., 2012), the lamina
348 parasphenoidalis is apparently situated lower than the condylus occipitalis, resulting in a
349 marked fossa subcondylaris.
350
351 KNM-KP 51011: Distal humerus and some associated shaft fragments. The specimen
352 agrees well in both size and morphology with the distal humerus of *L. lüi* (Zhang et al.,
353 2012).
354
355 KNM-KP 56949: Left tibiotarsus shaft and pedal phalanx. The midshaft morphology
356 compares well overall with extant *L. crumeniferus* OB 35, but the diameter is larger in
357 the fossil. The fossil also exhibits a more gradual taper, indicating a wider and longer
358 tibiotarsus than that of OB 35. The bone exhibits one flat surface, and would have been
359 semicircular in cross section. The lateral aspect of the bone is broken and missing, thus
360 the area of attachment of the fibula cannot be assessed. In *L. crumeniferus* OB 35, the
361 distalmost portion of the fibula joins the tibiotarsus, and fuses completely with it. A distal
362 pedal phalanx is also associated with this specimen; other than its very large size, it
363 compares closely with OB 35.
364
365 KNM-WT 56350: Distal right humerus of a marabou stork; slightly smaller than the other
366 two distal stork humeri from Kanapoi, meaning it is essentially indistinguishable in size
367 from extant *L. crumeniferus* OB 35. The proximal extension of the dorsal condyle is
368 weathered away, and the dorsal surface of the bone is missing.

KNM-WT 16081: Most of a synsacrum, lacking pelvic elements. Comparable in size and visible morphology to extant *L. crumeniferus* OB 35.

Genus *Mycteria*

Figures: 1B, 1C, IJ

Material examined: KNM-KP 50759, KNM-KP 30231

Locality and horizon: KNM-KP 50759: Kanapoi, lacustrine sequence

KNM-KP 30231: Kanapoi (below tuff)

Comparisons: KNM-KP 50759: Well-preserved proximal right femur. Compares very closely in all respects with same element of *Mycteria ibis* OB 49, although the fossil is slightly larger (Fig. 1J).

KNM-KP 30231: Distal pedal phalanx, fragment of distal left tarsometatarsus, left radiale, near-complete right tibiotarsus (proximal end, distal end, and shaft fragments), unidentified shaft fragments from a long bone, partial fibula. The radiale and distal end of tibiotarsus are well preserved, and are referable to *Mycteria* (Fig. 1B, 1C). This specimen was first noted and diagnosed by Harris et al. (2003).

Order Pelecaniformes

Family Pelecanidae

Genus *Pelecanus*

Figures: 1H

Material examined: KNM-WT 19627

Locality and horizon: West Turkana (NAI Photo R 22/2)

Comparisons: Specimen comprises the distal end of a right humerus, and the distal and proximal ends of a left humerus. The bones are massive and reasonably well preserved, although much of the bicipital and deltopectoral crests are eroded away on the proximal humerus. Apart from these preservational artifacts, the visible morphology of the specimen is virtually indistinguishable from extant *Pelecanus onocrotalus* OB 2334 (Fig. 1H).

Order Psittaciformes

Family Psittacidae

Figures: 1A

Material examined: KNM-KP 50759

415

416 Locality and horizon: KNM-KP 50759: Kanapoi, lower fluvial sequence

417

418 Comparisons: KNM-KP 58729: Complete left tarsometatarsus. The bone is stout overall,
419 with its proximal articular shelf offset laterally from the main axis of the bone. The squat
420 shape of the bone and its zygodactyl configuration are psittaciform synapomorphies
421 (Ksepka and Clarke, 2012). Although some of the bone surface remains obscured by
422 matrix, including much of the proximal articular surface, all visible morphology agrees
423 with a referral to Psittacidae. The hypotarsus bears a closed bony canal for the tendon of
424 the musculus flexor digitorum longus (furrow/canal no. 1 of Strauch, 1978). The fossil is
425 figured next to *Poicephalus meyeri* OB 274, with which it agrees well despite being
426 slightly larger (Fig. 1A). Matrix obscures part of the plantar region, precluding
427 assessment of whether the lateral foramen vasculare is displaced well proximal of its
428 medial counterpart as in extant parrots (Ksepka and Clarke, 2012).

429

430 **Order Apodiformes**

431 **Family Apodidae**

432

433 Figures: 1F

434

435 Material examined: KNM-KP 53036, KNM-KP 53040, KNM-KP 53041, KNM-KP
436 53045, KNM-KP 53007, KNM-KP 53008, KNM-KP 53009, KNP-KP 53014, KNM-KP
437 32825, KNM-KP 30640, KNM-KP 53037, KNM-KP 53034

438

439 Locality and horizon: KNM-KP 32825: Kanapoi (microfauna level).

440

441 Comparisons: KNM-KP 53036: Left phalanx proximalis digiti majoris; element is robust,

442 and exhibits broken articular surfaces.

443

444 KNM-KP 53040. Left proximal half of carpometacarpus exhibiting well-preserved

445 articular surfaces.

446

447 KNM-KP 53041: Small left ulna, three-dimensionally preserved, complete and

448 undamaged. Articular surfaces very well preserved. Radial and humeral fossae are both

449 deep. The crests on the distal surface are very deep and well developed.

450

451 KNM-KP 53045: Corpus major of right carpometacarpus.

452

453 KNM-KP 53007: Omal end of right coracoid; broken along the midshaft just sternal to

454 the procoracoid process. Massive acrocoracoid process completely preserved, with short

455 procoracoid process. Humeral articulation facet is complete and well preserved.

456 Procoracoid nerve foramen present. Cotyla scapularis shallow, directly adjacent to the

457 sternal extremity of the humeral articulation facet (Fig. 1F).

458

459 KNM-KP 53008: Distal ends of two left ulnae (practically identical). Very well

460 preserved. From a large swift; articular surfaces clearly demarcated.

KNM-KP 53009: Well-preserved proximal end of left radius; quite slight; agrees in terms of size and general morphology with *Apus horus* OB 333.

KNP-KP 53014: Distal end of right ulna. Relatively poorly preserved, but articular surfaces on distal end are well preserved and prominent. Agrees well with *A. horus* OB 333.

KNM-KP 32825: Right distal ulna of a large swift including part of the shaft; generally poorly preserved but articular surfaces generally clear.

KP 30640: Complete, very well preserved right ulna of a swift. Articular surfaces well preserved.

KNM-KP 53037: Largely complete phalanx proximalis digiti majori; muscle scars and associated crests are obvious, and distal articular surface is well preserved.

KNM-KP 53034: Very well preserved, near-complete right carpometacarpus of a swift (~the size of *A. horus* OB 333). The corpus minor is broken on its distal end, preserving nearly half its length. The rest of the bone is well preserved and complete.

Order Anseriformes

Family Anatidae

Figures: 1G

Material examined: KNM-WT 52128:

Locality and horizon: West Turkana; Nachukui. Deltaic setting within Nariokotome Member

Comparisons: KNM-KP 39326: This proximal left humerus fragment was previously referred to Anatidae, although confusingly also to Charadriiformes (Harris et al., 2003). The specimen is very poorly preserved, and is probably best referred to Aves indet.

KNM-WT 52128: Proximal left femur of a fairly large anatid, slightly smaller than Egyptian goose (*Alopochen aegyptiaca* OB 1637), with which it is compared in Fig. 1G. All aspects of morphology compare well with *A. aegyptiaca*, although much of the proximal surface is eroded away. The dorsal surface of the femoral head is flattened in both the fossil and OB 1637. A low crista trochanteris barely extends above the level of the femoral head.

Families: Columbidae/Pteroclididae?

Material examined: KNM-KP 53043, KNM-KP 53019

Locality and horizon: KNM-KP 53043: Kanapoi

KNM-KP 53019: Kanapoi

Comparisons: KNM-KP 53043: Moderately well preserved right distal humerus; some damage to the surface. The articular surfaces are fairly distinct. The specimen generally compares favorably with Columbidae and Pteroclididae, including *Pterocles exustus* OB 797.

KNM-KP 53019: Very poorly preserved distal end of left humerus; articular surfaces largely absent. Visible morphology agrees with Columbidae and Pteroclididae.

Order Strigiformes

Family Strigidae

Material examined: KNM-KP 30642

Locality and horizon: Kanapoi

Comparisons: Specimen is poorly preserved, and comprises the omal extremity of a right scapula, an ungual phalanx, and three unidentifiable bone fragments from a very small owl; comparable in size to *Glaucidium capense*.

Aves Indet.

Material examined: KNM-KP 53026

Locality and horizon: Kanapoi; “Joseph’s Trench”, Step 4

Comparisons: Distal end of a fairly large avian pedal phalanx. Agrees in general morphology and size with a mid- to small-sized bustard, although a firm diagnosis is not possible based on the limited material.

Order Charadriiformes

Family Recurvirostridae?

Material examined: KNM-KP 53046

Locality and horizon: Kanapoi

Comparisons: Partial proximal left humerus of a charadriiform bird; most of the caput humeri is present. The specimen exhibits a prominent tuberculum ventrale, connected to the humeral shaft via a sharp ridge. The specimen shows a deep and elongate fossa pneumotricipitalis, which, although in-filled with sediment, is clearly of the 'dual type, non-pneumatic' (Baumel and Witmer, 1993). Both the crista deltopectoralis and crista bicipitalis are broken close to the main shaft of the humerus. Caput humeri are separated from the tuberculum ventrale by a deep incisura capitis. In cranial view, a deep, laterally

extensive sulcus ligamentum transverus is visible. Although the crista bicipitalis is largely broken, what remains of the intumescentium humeri is broad. There is a deep impressio coracobrachialis, which terminates proximally in a broken edge; thus, the tuberculum dorsale is not preserved. The preserved edge of the crista deltopectoralis suggests that it was considerably longer than the crista bicipitalis (~30%). The sulcus n. coracobrachialis is shallow. Every aspect of the preserved and visible morphology compares with the humerus of *Recurvirostra avosetta* OB 1517.

Order Coraciiformes

Family Alcedinidae?

Material examined: KNM-KP 53061

KNM-KP 53018

Locality and horizon: Kanapoi

Comparisons:

KNM-KP 53061: Left ulna, proximal end. Both radial and humeral articulations are fairly shallow; radial articulation sub-rectangular in shape. Compares in all visible respects, including identical size, with *Alcedo cristata* OB 1117.

KNM-KP 53018: Shaft of a small right tarsometatarsus. Element is relatively stout; the distal trochleae are broken, as is most of the proximal surface of the element. The element is of comparable size to *Alcedo cristata* OB 1117.

Order Passeriformes

Material examined: KNM-KP 53044, KNM-KP 53003, KNM-KP 53005, KNM-KP 53006, KNM-KP 53016, KNP-KP 53021, KNM-KP 53029, KNM-KP 53004, KNM-KP 53017, KNM-KP 53042, KNM-KP 53035, KNM-KP 53033, KNM-KP 53032, KNM-KP 53027, KNM-KP 53023, KNM-KP 53015

Locality and horizon:

KNM-KP 53044: Kanapoi

KNM-KP 53003: Kanapoi

KNM-KP 53005: Kanapoi

KNM-KP 53006: Kanapoi

KNM-KP 53016: Kanapoi “bat site”

KNP-KP 53021: Kanapoi

KNM-KP 53029: Kanapoi

KNM-KP 53004: Kanapoi "Wambua's hominid, Step 3"

KNM-KP 53017: Kanapoi "bat site"

KNM-KP 53042: Kanapoi

KNM-KP 53035: Kanapoi

KNM-KP 53033: Kanapoi

KNM-KP 53032: Kanapoi

KNM-KP 53027: Kanapoi

KNM-KP 53023: Kanapoi "microfauna Nichola dP4-sieve WT 3425"

KNM-KP 53015: Kanapoi

General notes:

KNM-KP 53044: Left distal humerus of a small passeriform; very friable and poorly preserved.

KNM-KP 53003: Complete, three-dimensionally preserved right carpometacarpus; Articular surfaces well preserved.

KNM-KP 53005: Small, very well preserved distal extremity of left humerus; articular surfaces well preserved.

KNM-KP 53006: Small, moderately well preserved distal end of right ulna.

KNM-KP 53016: Tiny, broken proximal end of carpometacarpus.

KNP-KP 53021: Small, very well preserved proximal end of right carpometacarpus.

KNM-KP 53029: Distal end of left tarsometatarsus; tiny and very slender. No phalangeal trochleae are preserved and the element seems unlikely to be further diagnosable.

KNM-KP 53004: Left carpometacarpus from a small passerine, well preserved and nearly complete, corpus minor not preserved.

KNM-KP 53017: Left distal ulna. Small element, generally poorly preserved.

KNM-KP 53042: Tiny, very well preserved omal extremity of a coracoid and much of the shaft. The humeral articulation facet, acrocoracoid process, and procoracoid process all well preserved. The procoracoid process is very short; cotyla scapularis not notably concave; humeral articulation facet elongate and narrow, acrocoracoid process very pronounced and broad.

KNM-KP 53035: Tiny, left distal ulna with much of the shaft preserved.

KNM-KP 53033: Tiny, right distal ulna, with articular surfaces at the wrist well preserved.

KNM-KP 53032: Omal extremity of a very small right coracoid. Agrees well with KNM-KP 53042. The specimen exhibits a negligible procoracoid process, a poorly defined, non-concave cotyla scapularis, and a broad, well-developed acrocoracoid process. The

shaft is broken just below the procoracoid process. The humeral articulation facet is preserved in its entirety.

KNM-KP 53027: Generally poorly preserved and very small right distal ulna including some of the shaft.

KNM-KP 53023: Fairly well preserved right distal ulna of a mid-sized passerine.

KNM-KP 53015: Tiny, right distal ulna of a passerine bird. Not well preserved.

Order Accipitriformes

Family Accipitridae

Subfamily cf. Aegypiinae

Figures: 1E

Material examined: KNM-WT 16156, KNM-WT 19983

Locality and horizon: Kanapoi

KNM-WT 16156: West Turkana (Lo. 9).

KNM-WT 19983: West Turkana (Hippo Site)

Comparisons:

664 KNM-WT 16156: Right distal ulna and some of the shaft from a large raptor; some of the
665 articular surface is preserved. Compares closely with Aegypiinae.
666
667 KNM-WT 19983: Complete, three-dimensionally preserved right ulna from a large
668 raptor. The fossil preserves short, poorly defined quill knobs, comparable to those on the
669 ulna of *Trigonoceps occipitalis* OB 957. Although generally similar to the ulna of *L.*
670 *crumeniferus*, the humerus of *L. crumeniferus* is ~8% longer, has quill knobs that are
671 much more clearly defined, extensive pneumatization at the proximal and distal ends of
672 the bone, a more laterally elongated humeral articulation, a less deeply excavated
673 impressio brachialis, a more sharply pointed tuberculum carpale, and a pronounced and
674 acute tubercle on the distal extremity of the condylus ventralis ulnae.
675
676 **4. Discussion**
677 While the present study represents a preliminary investigation, the early Pliocene
678 fossil avifauna from Kanapoi clearly represents a diverse taxonomic assemblage. It
679 appears broadly comparable to that described from the Miocene locality of Lothagam
680 (Harris and Leakey, 2003), although the mammalian faunas from these localities differ
681 considerably (Bobe, 2011). Despite the fact that only a comparatively small sample of
682 avian fossils has been examined to date, no fewer than 12 family-level clades are
683 represented between Kanapoi and the more recent Turkana localities. Additionally, at
684 least some of these clades are represented by multiple taxa, including storks (Ciconiidae),
685 which are represented by both *Mycteria* and *Leptoptilos*. Given that additional avian
686 material has been surface collected from Kanapoi and the more recent localities (and thus

687 far been unavailable for examination), it is almost certain that the diversity of this avian
688 assemblage is strongly undersampled. This is underscored by the fact that only a minority
689 of the Kanapoi avian material has thus far proven diagnosable to family, and it is likely
690 that future attention and sampling via surface collection and sieving will shed additional
691 light on the affinities of these remains. A prior survey of the Kanapoi fossil avifauna
692 (Harris et al., 2003) revealed the remains of only four avian taxa in the form of numerous
693 ostrich eggshell specimens, several fragmentary long bones from *Mycteria,* a tentatively-
694 referred fragmentary duck humerus, and a complete *Anhinga* humerus. It seems certain
695 that additional sampling from Kanapoi and the younger West Turkana localities will
696 continue to reveal an interesting diversity of fossil birds with potential to shed light on
697 the paleoenvironment of *A. anamensis*, and the composition of East African Pliocene
698 avifaunas.
699
700 *4.1. Kanapoi paleonenvironment, and early Pliocene hominin niche partitioning*
701
702 The avian fossils from Kanapoi and the more recent West Turkana localities
703 reveal an obvious ecological signal. Although the general tetrapod assemblage at Kanapoi
704 was initially described as broadly similar to the comparably aged (though slightly older)
705 assemblage from Aramis, Ethiopia (Harris et al., 2003), more recent work (e.g., Louchart
706 et al., 2009) as well as the present avian dataset stands in stark contrast to this
707 assessment. In addition to producing fossil hominin remains, Aramis represents the most
708 extensively evaluated early Pliocene avifauna from East Africa. A survey of that avifauna
709 (Louchart et al., 2009) yielded at least 370 catalogued avian specimens, representing 29

710 species and 16 families. Among the 296 diagnosable elements from this avifauna, only
711 3.8% represented aquatic taxa (Louchart et al., 2009). Most small elements were
712 interpreted to have derived from owl pellets, and collectively, the paleoenvironment at
713 Aramis was determined to represent one dominated by mesic woodlands (Louchart et al.,
714 2009).

715 By contrast, the broader West Turkana avifauna is comparatively dominated by
716 aquatic taxa, which comprise 27% (Kanapoi) and 71% (more recent localities) of the
717 avian fossils diagnosed to date. The majority of extant waterbird diversity (Aves:
718 Aequorlitornithes) is the product of a large monophyletic radiation uniting, among many
719 other groups, shorebirds (Charadriiformes), storks (Ciconiiformes), darters (Suliformes:
720 Anhingidae), and pelicans (Pelecaniformes: Pelecanidae) (Prum et al., 2015). In addition
721 to these aequorlitornithid representatives, the broader West Turkana avifauna comprises
722 representatives of at least two additional aquatic lineages: waterfowl (Anseriformes:
723 Anatidae), and a probable kingfisher (Coraciimorphae: Alcedinidae). The Kanapoi
724 avifauna is entirely consistent with the idea that *A. anamensis* from this locality lived
725 alongside a large, slow-moving body of water. The stark difference in both the taxonomic
726 composition and comparative abundance of taxa from the Kanapoi and Aramis avifaunas
727 may be suggestive of divergent habitat preferences (if not ecological niche partitioning)
728 among early Pliocene hominins in East Africa.
729
730 *4.2. Implications for the origins of Africa's extant avifauna*
731
732 Today, Africa's avifauna is extraordinarily diverse—represented by over 2,500

733 living species (Brown et al., 1982). However, a relatively sparse avian fossil record has
734 hindered our understanding of the pattern and timing of Africa's avifaunal assembly
735 (Louchart et al., 2005, 2009; Mayr, 2009). As such, the fossil assemblage at Kanapoi may
736 have much to contribute to our understanding of avian evolution in the Pliocene of East
737 Africa. Although the present contribution represents a preliminary assessment, the future
738 incorporation of avian fossils from Kanapoi into detailed character-taxon datasets may
739 yield insights into the precise phylogenetic placement of these specimens. Indeed, these
740 fossils may variously provide useful apical minimum constraints in node-dating
741 divergence time analyses, help illuminate the evolution of African avian biogeography,
742 and shed light on the broader evolutionary history of East African birds. The evolutionary
743 relationships and biogeographic origins of several major clades of African endemic birds
744 have long remained obscure (e.g., turacos; Musophagidae, secretarybirds; Sagittariidae,
745 shoebills; Balaenicipitidae), a product, in large part, of their extremely scarce fossil
746 records. The detailed examination of avian remains from localities like Kanapoi may
747 ultimately help clarify how, when, and where the modern constituents of the East African
748 avifauna came to be.
749
750 *4.3. Giant extinct marabou storks, and the antiquity of marabou-hominin interactions*
751
752 One of the most striking aspects of the Kanapoi avifauna is the relative abundance
753 of a giant marabou stork, larger than the extant marabou *L. crumeniferus* (represented by
754 eight specimens from Kanapoi). Although a giant extinct marabou, *L. falconeri*, has been
755 reported from the Pliocene of Chad and Ethiopia (after initially being described from the

Siwalik Hills of Pakistan; Louchart et al.,2005), the occurrence of this taxon in the early Pliocene of Kenya represents an extension of its known geographic range in East Africa. Previously, remains of fossil marabous from Kenya had been reported from only the late Miocene locality of Lothagam, northern Kenya (Upper Nawata Member, between 5.3 and 6.5 Ma (McDougall and Feibel, 1999; Harris and Leakey, 2003; Louchart et al., 2005) and the Miocene locality of Ngorora (Baringo, ca. 11.5Ma; Hill and Walker, 1978; Louchart et al., 2005).

Previous descriptions of *L. falconeri* material comprise only distal tibiotarsi, distal tarsometatarsi, pedal phalanges, a fragmentary carpometacarpus, and a vertebra. The material herein referred to *L.* cf. *falconeri* represents a neurocranium and quadrate, much of the forelimb (portions of the humerus, ulna, os carpi ulnare, os carpi radiale, proximal carpometacarpus and manual phalanx), hindlimb (pedal phalanges, proximal tarsometatarsus, tibiotarsus) and synsacrum. While these remains are fragmentary, scaling equations (e.g., Field et al., 2013) should allow for the future study of body size evolution in Leptoptilini, a subject of current research interest (Louchart et al., 2005; Meijer and Due, 2010; Zhang et al., 2012). Future detailed study of the *Leptoptilos* material recovered from Kanapoi will doubtless shed considerable additional light on the morphology of giant Neogene marabous, despite the fact that the cranial remains are presently in need of additional mechanical preparation. The rarity of fossil *Leptoptilos* crania (Zhang et al., 2012) renders the Kanapoi remains of particular interest, and may enable the future investigation of endocranial morphology and detailed anatomical comparisons with extant marabous using computed tomographic reconstructions (Balanoff et al., 2016). Full descriptions and analysis of the Kanapoi *Leptoptilos* material,

779 which is beyond the scope of the present contribution, promises to reveal many new
780 details about the morphology of this gigantic Pliocene stork.
781 The scavenging ecology of extant marabous (i.e., their propensity to feed on
782 human refuse), and the relatively frequent co-occurrence of fossil marabous and early
783 human relatives from the Miocene through the Pleistocene (Harris and Leakey, 2003;
784 Louchart et al., 2005, 2008; Zhang et al., 2012) raises the interesting (though presently
785 speculative) possibility of multi-million-year commensalism between marabous and early
786 humans (H. James, personal communication). The occurrence of both *L.* cf. *falconeri* and
787 the earliest-known australopithecines at Kanapoi may lend some support to this idea.
788 Perhaps the association between humans and marabous, which today are abundant around
789 urban areas throughout East Africa, reflects the result of over five million years of
790 acclimation to mutual coexistence.
791
792 *4.4. Taphonomy of Kanapoi avian remains*
793
794 The vast majority of the avian remains from Kanapoi and the more recent West
795 Turkana localities are broken and isolated, an observation consistent with sorting by
796 moving water (Louchart et al., 2009; Longrich et al., 2011). In contrast to the small
797 vertebrate remains recovered from Aramis, few or none of the avian remains examined
798 here exhibit obvious signs of feeding by rodents or chewing by mammalian carnivores,
799 underscoring the taphonomic distinctness of these two localities. The relative abundance
800 and damage of many of the small vertebrate remains from Aramis were interpreted to be
801 consistent with their derivation from owl pellets; however, the Kanapoi fossils exhibit

802 little evidence in support of a similar taphonomic history. Sorting due to water transport
803 may in part contribute to the considerable diversity of the Kanapoi avifauna despite the
804 modest number of elements collected and examined to date: in addition to autochthonous
805 bird carcasses that may have been deposited nearby, the assemblage may also reflect
806 allochthonous avian remains transported by water from more distal settings.
807
808 **5. Conclusion**
809 Louchart et al. (2009) suggest that the fossil avifauna from the *Ardipithecus*-bearing
810 Aramis locality reflected a taphonomic setting where most carcasses were buried, without
811 transport, in a mesic woodland environment far from water. By contrast, the bird fossils
812 from the roughly contemporaneous *A. anamensis*-bearing sites of Kanapoi lack any
813 notable woodland signal, and the presence of a variety of aquatic taxa is instead
814 suggestive of a setting close to water. The paleoecological differences between these sites
815 suggest possible differentiation in environmental preferences between contemporaneous
816 hominin taxa in East Africa, and the presence of the large Pliocene marabou stork *L.* cf.
817 *falconeri* may reflect a long-term commensal relationship between marabous and
818 hominins. In sum, geological, taphonomic, and taxonomic evidence are indicative of an
819 ecological setting in close proximity to a large, slow-moving water body for *A.*
820 *anamensis* at Kanapoi. This work emphasizes the utility of fossil birds as sensitive
821 environmental indicators (Olson and Rasmussen, 1986), and their potential contribution
822 to paleoecological reconstructions of early hominin paleoenvironments.
823
824 **Acknowledgements**

I am grateful to C. Ward, M. Plavcan, and F. Manthi for the invitation to take part in this research, D. Matthieson for her initial work on the fossil birds from Kanapoi, A. Louchart, M. Plavcan, and C. Ward for helpful and constructive reviews of this manuscript, and C. Brochu (East African birds), H. James (human-marabou commensalism), and S. Frost (small vertebrate taphonomy) for helpful discussions during the course of this study. Funding for this project was provided by NSF BCS-1231749, NSF BCS-1231675, the Wenner Gren Foundation, and the University of Missouri Research Board. DJF is supported by a 50th Anniversary Prize Fellowship at the University of Bath.

Figure Captions

Fig. 1: Selected non-*Leptoptilos* avian fossil material from Kanapoi and West Turkana. Scale bar equals 1cm. 2A: tarsometatarsus of Psittacidae KNM-KP 58729 (left), and extant *Poicephalus meyeri* OB 274 (right), in cranial view; 2B-C: distal right tibiotarsus of stork (Ciconiidae: *Mycteria*) KNM-KP 30231 (right) and extant *Mycteria ibis* OB 49 (left) in cranial (2B) and lateral (2C) view; 2D: left humerus of *Anhinga* KNM-KP 39325 (right) and extant *Anhinga rufa* OB 1411, in dorsal view; 2E: right ulna of vulture (Accipitridae: Aegypiinae) KNM-WT 19983 (right) and extant *Trigonoceps occipitalis* OB 957 (left), in ventral view; 2F: Omal extremity of right coracoid of swift (Apodidae) KNM-KP 53007 (left), and extant *Apus horus* OB 333 (right); 2G: proximal left femur of Anatidae KNM-WT 52128 (right), and extant *Alopochen aegyptiaca* OB 1637 (left), in cranial view; 2H: proximal left humerus of *Pelecanus* KNM-WT 19627 (left) and extant *Pelecanus onocrotalus* OB 2334 (right), in cranial view; 2I: distal right tibiotarsus of

848 *Anhinga* KNM-KP 53159 (left) and extant *Anhinga rufa* OB 1411 (right), in cranial view;
849 2J: proximal right femur of stork (Ciconiidae: *Mycteria*) KNM-KP 50759 (left), and
850 extant *Mycteria ibis* OB 49 (right), in cranial view.
851
852 Fig. 2: Selected fossil marabou stork (Ciconiidae: *Leptoptilos*) material from Kanapoi and
853 West Turkana. Scale bar equals 1cm. 1A-C: neurocranium KNM-KP 53164 in dorsal
854 (1A), posterior (1B), and right lateral (1C) view; 1D: synsacrum KNM-WT 16081 in
855 dorsal view (left), modern *L. crumeniferus* OB 35 (right); 1E: proximal tarsometatarsus
856 KNM-KP 50800 in cranial view; 1F: distal right humerus KNM-KP 50804 in cranial
857 view; 1G: distal right ulna KNM-KP 50764 (left), extant *L. crumeniferus* OB 35 (right) in
858 ventral view; 1H: proximal right carpometacarpus KNM-KP 50764 (left), extant *L.*
859 *crumeniferus* OB 35 (right); 1I: ulnare KNM-KP 50764 (left), extant *L. crumeniferus* OB
860 35 (right); 1J: radiale KNM-KP 50760 (left), extant *L. crumeniferus* OB 35 (right).
861
862 Fig. 3: Dominant avian ecologies represented at Kanapoi and the more recent Turkana
863 localities, compared to the slightly older fossil avifauna from Aramis, Ethiopia (based on
864 skeletal data; Aramis data from Louchart et al., 2009). Aquatic birds and aerial
865 insectivores (swifts) together comprise the dominant avian lifestyles represented at
866 Kanapoi, with aquatic birds dominating at the more recent localities. By contrast, aquatic
867 birds and swifts are extremely rare at Aramis.
868
869 Fig. 4: Comparison of the dominant avian taxa represented at Kanapoi, the more recent
870 Turkana localities, and Aramis (Aramis data from Louchart et al., (2009)). The dominant

clades at Kanapoi and the more recent localities, including storks (Ciconiidae), swifts (Apodidae), and songbirds (Passeriformes) are poorly represented at Aramis, where small parrots (Psittacidae), barn owls (Tytonidae), and landfowl (Galliformes; comprising *Francolinus*, *Pavo*, and Numididae) are dominant. Predominantly aquatic taxa (in blue) are extremely scarce at Aramis, but comparatively abundant at Kanapoi and the more recent Turkana localities.

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